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MANHATTAN DISTRICT HISTORY

BOOK V - ELECTROMAGNETIC PROJECT

VOLUME 6 - OPERATIONS

TOP SECRET APPENDIX

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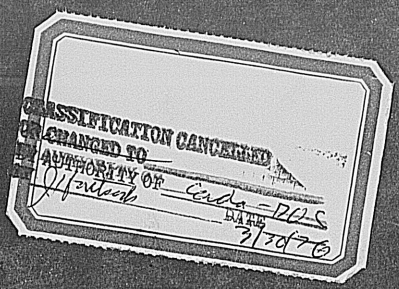

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APPENDIX

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Status of Electromagnetic Project as of 31 December 1946.

1. Initial Operations - During the latter part of 1943, the Alpha Section (XAX) in the Pilot Plant, Building 9731, was in operation. Vacuum testing started 7 August 1943 with nine men on three shifts. This operation had for its primary objective the training of the initial personnel required to operate the Alpha I buildings and at the same time acquire as much knowledge as possible of the equipment and its characteristics; for organizational purposes, it was necessary to acquire a knowledge of the people, their abilities, and their characteristics.

2. Production Operations - The several production units began to operate, beginning on 22 January 1944 and continued as indicated in the schedule shown in the following table:

Alpha Track No. 1	- 13 November 1943 (1st Temporary Start)
	- 3 March 1944
Alpha Track No. 2	- 22 January 1944
Alpha Track No. 3	- 19 March 1944
Alpha Track No. 4	- 12 April 1944
Alpha Track No. 5	- 3 June 1944
Alpha Track No. 6	- 24 July 1944
Alpha Track No. 7	- 26 August 1944
Alpha Track No. 8	- 24 September 1944
Alpha Track No. 9	- 26 October 1944
Beta Track No. 1	- 15 March 1944
Beta Track No. 2	- 5 June 1944
Beta Track No. 3	- 12 September 1944
Beta Track No. 4	- 2 November 1944
Beta Track No. 5	- 30 January 1945
Beta Track No. 6	- 13 December 1944
Beta Track No. 7	- 1 December 1945
Beta Track No. 8	- 15 November 1945

Two years and two days elapsed from the starting of Alpha Track No. 1 and Beta Track No. 8.

a. Alpha Production - The feed material for the Alpha Stage was received by year as indicated below:

Year	Kg. U-235	% U-235	Kg. U
1943	53.28	.71	7,503.58
1944	907.88	.71	127,854.03
1945	779.18	.77(Ave)	100,621.74
1946	-	-	-
Total	1,740.34	.74(Ave)	235,979.35

This material for feed was received in the form of trioxide, tetrachloride, dioxide, pentrachloride, hexafluoride, a small amount of residues, salvage from Beta and a large amount of miscellaneous material from U.S.E.D. The chief sources were Mallinckrodt, Harshaw, Fercleve, Carbide and Carbon, and U.S.E.D.

The uranium was removed from the Alpha Cycle as follows:

Year	Kg. U-235	% U-235	Kg. U
1943	--	--	--
1944	425.43	.72	59,488.59
1945	1,314.91	.75	176,480.77
1946	--	--	--
Inventory as of 6/2/46	0.73	.40	184.16
Total	1,741.07	.74	236,153.52
Material unaccounted for	242.84	.64	37,726.84 (15.99% of total)

Of the amount removed from Alpha Cycle there was added to the Beta Cycle as follows:

Year	Kg. U-235	% U-235	Kg. U
1943	--	--	--
1944	23.129	11.00	210.24
1945	72.728	9.71	749.71
1946	--	--	--
Total	95.857	9.99	959.95

Of this total amount, 3.49 Kg. of Uranium containing .327 Kg. U-235 was unaccounted for in refining Oxide. 168,196.96 Kg. of unused feed material was returned to the U.S.E.D.

b. Beta Production - The production, based on 100% U-235, of the Beta Stage from the beginning of operations thru 29 December 1946, appear in the following table:

All production to 0700 1 January 1945	8,690.1
0700 1 January 1945 to 0700 30 December 1945	224,070.3
0700 30 December 1945 to 0700 29 December 1946	808,266.1
Total to Date 29 December 1946	1,041,026.5 grams

c. Process Waste - The waste from process was of three types: one in solution and of such low concentration that it would not be possible to economically concentrate and recover; this was turned over to the Government (U.S.E.D.) to be disposed of by storing in a reservoir for same; the second in solid salvage and so low in concentration that it could not be economically recovered by strong acid or by destructive fluorination of the solids; the third constituting a relatively small amount that was adhering to equipment in such a manner that it could not be removed without destroying the equipment.

3. Efficiency of Operation - The efficiency of the operation is best seen by a comparison of the X and T utilization figures, when

X* utilization efficiency, $\frac{RX^*}{RX + QX + \text{Discarded Salvage X} + \text{Unaccounted-for X}}$

T* utilization efficiency, $\frac{RT + QT}{RT + QT + \text{Discarded Salvage T} + \text{Unaccounted-for T}}$

Year	XUE	TUE
1944	65.0%	74.0%
1945	91.7%	93.3%

* Q - ionized material received and collected in the U-238 section, or the Q pocket of the Receiver.

* R - Ionized material received and collected in the U-235 section, or the R pocket of the Receiver.

* X - Is U-235

* T - Is total Uranium formerly referred to as Tuballoy and includes all uranium isotopes.

Therefore, RX is X received in R pocket,
QX is X received in Q pocket,
RT is total U found in R pocket, and
QT is total U found in Q pocket.

Because of certain changes in design, an XPE of 24.5% was averaged on 19 runs. This represents over 100% increase in production per unit, within the past year.

The over-all losses have aggregated 17.4% of the amount received in Alpha Plant and 5.4% of the amount received in the Beta Plant.

Another efficiency is based on the ratio of the amount of U-235 collected to the amount in the vaporized charge material. This XPE* is shown as follows:

Year	X.P.E.
1943	--
1944	--
1945	11.7
1946	14.9

*XPE-U-235 Process Efficiency.

The production of U-235 by the electromagnetic process is shown as accumulated totals and percent concentration of the U-235.

BETA PRODUCTION THROUGH 1946 in U-235.

Accumulated Totals in Grams

Date	Total in Grams	R X C %
10-7-44	1,747.7	67.5
10-21-44	2,293.4	68.9
10-28-44	2,589.1	69.3
11-19-44	3,830.6	70.6
3-4-45	20,390.84	77.2
3-25-45	24,919.06	78.1
4-22-45	30,541.16	79.0
5-20-45	35,638.19	79.9
7-17-45	52,506.91	81.6
8-12-45	66,734.14	82.6
9-9-45	88,201.34	84.5
12-2-45	182,143.55	88.9
12-30-45	231,458.28	90.1
~~12-31-46~~ 12-29-46	~~1,045,009.00~~ 1,041,026.5	Approx. 95%

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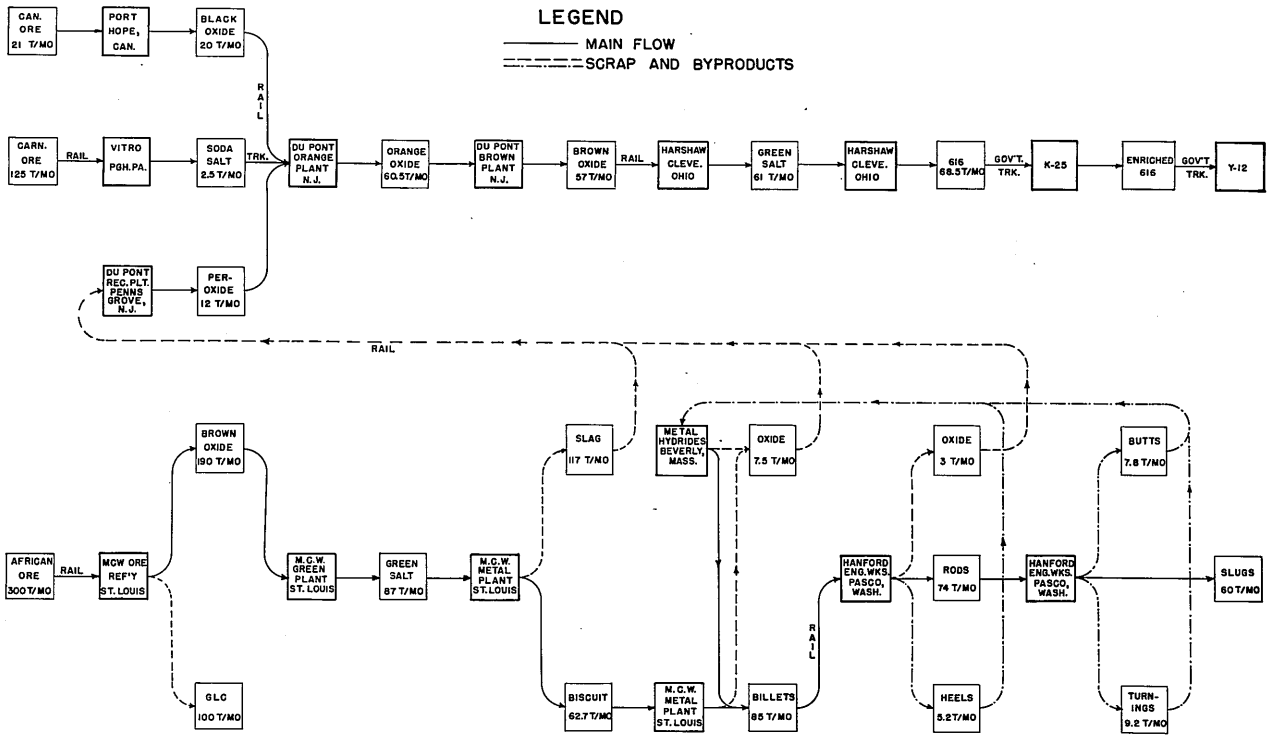
1	Uranium Production Flow Diagram	
2	Y-12 Flow Chart	
3	Alpha Chemistry Flow Chart	
4	Beta Chemistry Flow Chart	
5	Shipment of U 235 from Electromagnetic Plant	
6	Principle and Functioning of the Mass Spectrograph	

URANIUM PRODUCTION FLOW DIAGRAM



Y-12 PROJECT

CONCENTRATION OF URANIUM ISOTOPE 235 BY MASS SPECTROGRAPH

FEED MATERIALS PRESENT

FIRST CHEMICAL PROCESSING

FIRST MASS SPECTROGRAPH CONCENTRATION

SECOND CHEMICAL PROCESSING

SECOND MASS SPECTROGRAPH CONCENTRATION

FINAL CHEMICAL PROCESSING

URANIUM HEXAFLUORIDE FROM K-25 (.71% ISOTOPE 235)

URANIUM HEXAFLUORIDE FROM Y-30 (.85% ISOTOPE 235)

URANIUM TRIOXIDE FROM MADISON SQUARE AREA (.71% ISOTOPE 235)

ALPHA CHEMISTRY

URANIUM COMPOUNDS CONVERTED TO URANIUM TETRACHLORIDE AND LOADED INTO CHARGE CONTAINER FOR USE AS FEED IN ALPHA PROCESS

URANIUM TETRACHLORIDE ABOVE 1% ISOTOPE 235

ALPHA PROCESS

URANIUM TETRACHLORIDE IS VAPORIZED AND CONCENTRATED TO GIVE ALPHA PRODUCT

ALPHA PRODUCT 10% ISOTOPE 235

BETA CHEMISTRY

ALPHA PRODUCT IS PURIFIED AND CONVERTED TO URANIUM TETRACHLORIDE FOR USE AS FEED IN BETA PROCESS

URANIUM TETRACHLORIDE 10% ISOTOPE 235

BETA PROCESS

URANIUM TETRACHLORIDE (CONTAINING 10% ISOTOPE 235) IS VAPORIZED AND ISOTOPE 235 FURTHER CONCENTRATED TO GIVE BETA PRODUCT

BETA PRODUCT CHEMISTRY

BETA PRODUCT IS CONVERTED TO URANIUM TETRAFLUORIDE

URANIUM TETRAFLUORIDE 90% ISOTOPE 235

EQUIPMENT WASHINGS RETURNED FOR RECOVERY OF URANIUM

EQUIPMENT WASHINGS RETURNED FOR RECOVERY OF URANIUM

~~FUTURE~~

URANIUM HEXAFLUORIDE FROM K-25 (20-25% ISOTOPE 235)

— ALPHA FEED
· BETA FEED
BETA PRODUCT
– – – – – FUTURE FEED

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ALPHA CHEMISTRY

URANIUM HEXAFLUORIDE FROM K-25
11% URANIUM 235

URANIUM HEXAFLUORIDE FROM S-50
0.85% URANIUM 235

URANIUM HEXAFLUORIDE

CONVERSION OF URANIUM HEXAFLUORIDE TO URANIUM TRIOXIDE

URANIUM HEXAFLUORIDE IS DISSOLVED IN WATER AND THE URANIUM IS PRECIPITATED AS URANIUM PEROXIDE WHICH IS FILTERED, DRIED, AND DECOMPOSED AT HIGH TEMPERATURES TO URANIUM TRIOXIDE.

URANIUM TRIOXIDE

PREPARATION OF CRUDE URANIUM TETRACHLORIDE

URANIUM TRIOXIDE IS CONVERTED TO CRUDE URANIUM TETRACHLORIDE BY HEATING WITH CARBON TETRACHLORIDE UNDER PRESSURE.

CRUDE URANIUM TETRACHLORIDE

PURIFICATION OF THE CRUDE URANIUM TETRACHLORIDE

CRUDE URANIUM TETRACHLORIDE IS PURIFIED BY VAPORIZING THE PURE URANIUM TETRACHLORIDE LEAVING THE IMPURITIES BEHIND.

PURIFIED URANIUM TETRACHLORIDE

FILLING OF CHARGE CONTAINERS FOR ALPHA PROCESS

PURIFIED URANIUM TETRACHLORIDE IS LOADED INTO SMALL METAL CONTAINERS FOR CHARGING INTO THE ALPHA PROCESS.

ALPHA PROCESS
(SEE CHART NO 4 FOR DESCRIPTION)

URANIUM TETRACHLORIDE REMAINING IN CHARGE CONTAINERS

RECYCLE OF URANIUM UNCONCENTRATED IN U235

RECYCLE OF URANIUM UNCONCENTRATED IN U235

URANIUM TRIOXIDE FROM MADISON SQUARE AREA
0.71% URANIUM 235

RECOVERY OF URANIUM TRIOXIDE FROM WASH SOLUTION

URANIUM IS RECOVERED FROM THE CRUDE WASH SOLUTION BY PRECIPITATION AS URANIUM PEROXIDE WHICH IS SEPARATED FROM THE IMPURITIES REMAINING IN SOLUTION BY FILTRATION AND THEN DRIED AND DECOMPOSED BY HIGH TEMPERATURE HEATING TO PURE URANIUM TRIOXIDE.

CRUDE WASH SOLUTION

RECOVERY OF URANIUM FROM MASS SPECTROGRAPH PARTS

URANIUM IS RECOVERED FROM THE MASS SPECTROGRAPH PARTS AS A CRUDE SOLUTION BY WASHING WITH WATER, STEAM, AND CHEMICALS.

ALPHA FEED ——
PROCESS - - - - - -

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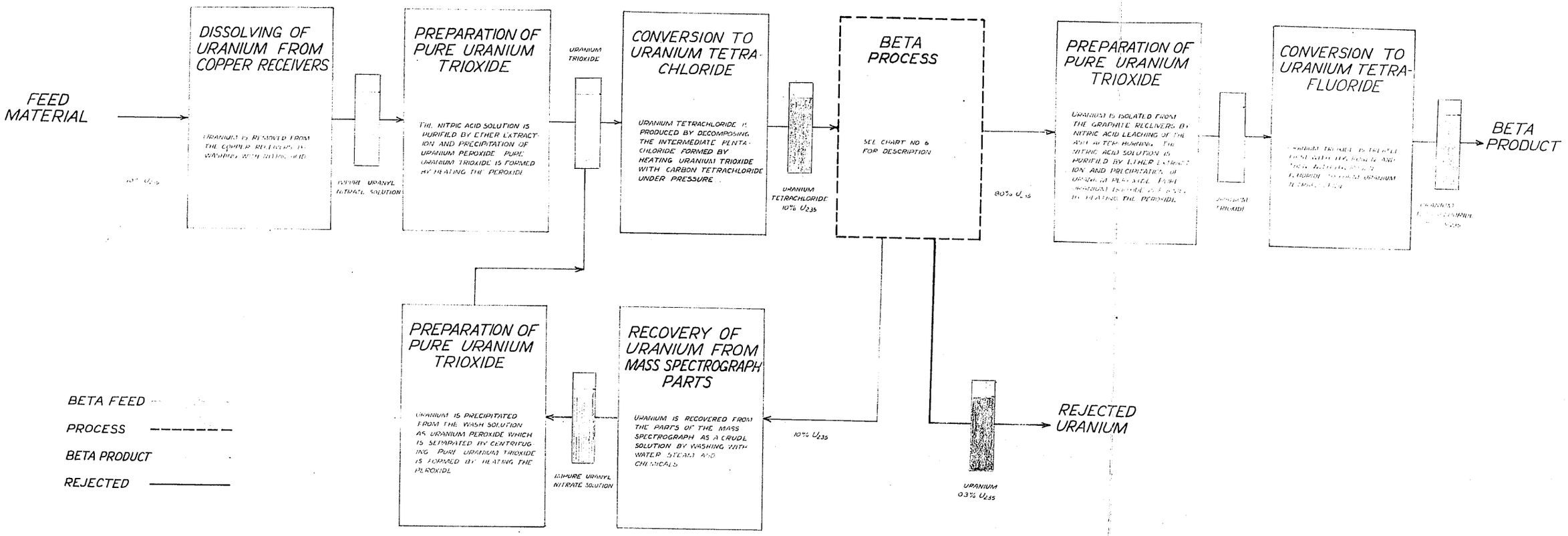
BETA CHEMISTRY

BETA PRODUCT CHEMISTRY



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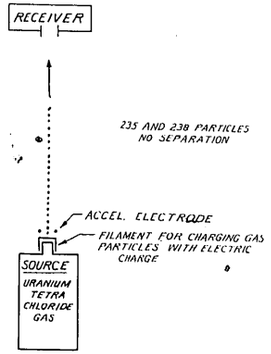
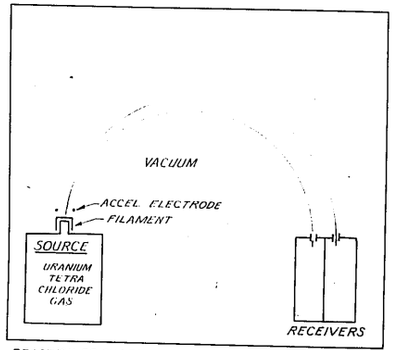
PRINCIPLE AND FUNCTIONING OF MASS SPECTROGRAPH

FUNDAMENTAL THEORY
REASON FOR USE OF MAGNETIC FIELD

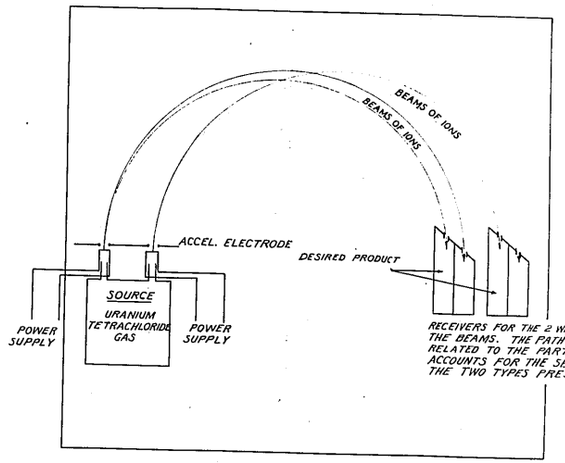


REACTION OF CHARGED PARTICLES OF GAS IN VACUUM WITHOUT MAGNETIC FIELD. NO SEPARATION OF DIFFERENT MASS PARTICLES TAKES PLACE.



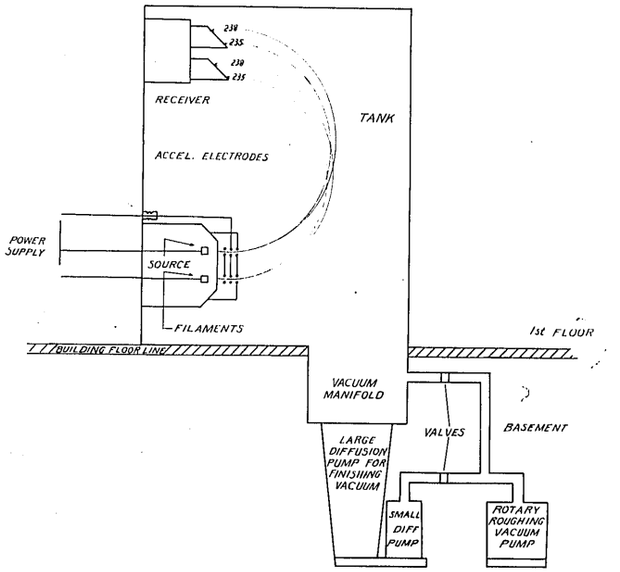
REACTION OF CHARGED PARTICLES OF GAS OF DIFFERENT MASSES WHEN OPERATION IS PERFORMED IN PRESENCE OF MAGNETIC FIELD. THE MAGNETIC FIELD CAUSES PARTICLES OF DIFFERENT MASSES TO FOLLOW DIFFERENT PATHS AND THUS EFFECTS SEPARATION OF PARTICLES OF U_{235} AND U_{238}.

FUNDAMENTAL MASS SPECTROGRAPH SYSTEM AS APPLIED TO Y-12 PROJECT



RECEIVERS FOR THE 2 WEIGHTS OF IONS IN THE BEAMS. THE PATH TAKEN IS DIRECTLY RELATED TO THE PARTICLE MASS AND ACCOUNTS FOR THE SEPARATION OF THE TWO TYPES PRESENT.

ONE PRODUCTION UNIT OF A Y-12 RACE TRACK SIDE VIEW



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CUMULATIVE SHIPMENTS OF U-235 FROM ELECTROMAGNETIC PLANT TO LOS ALAMOS 1944-1946

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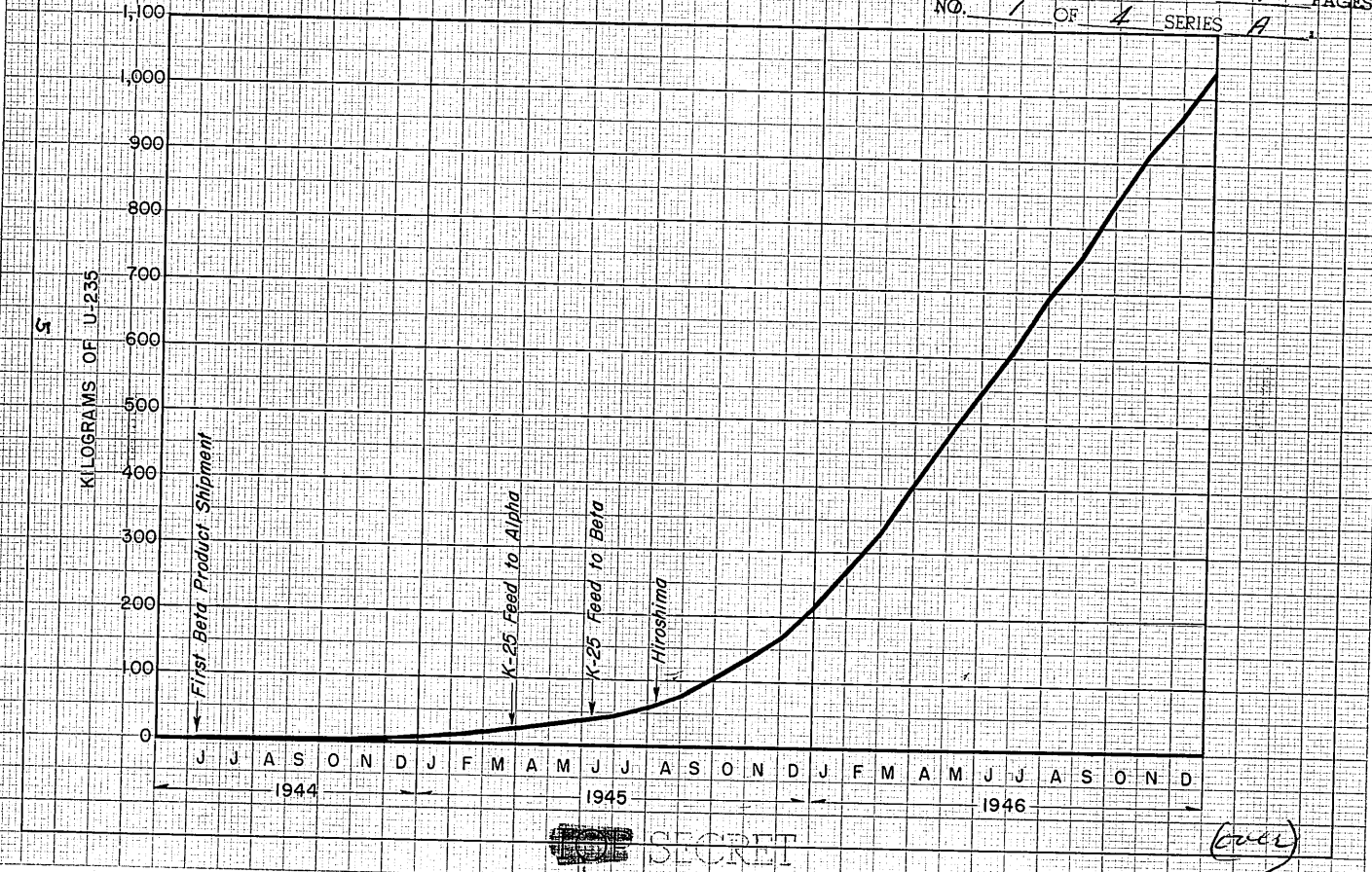
NO. 1 OF 4 SERIES A



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M. Dawson
6/27/57

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